Enabling Exploration: NASA's Technology Needs

Carol W. Carroll
Deputy Director of Science
NASA Ames Research Center

University of Oregon
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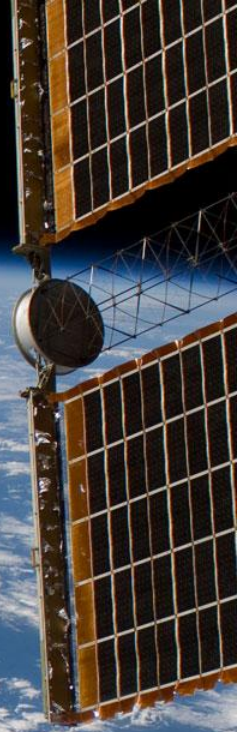
SPACE EXPLORATION: THE NEXT STEPS

The end of an era July 21, 2011:
30 years of Space Shuttle Exploration

NASA is changing its approach to Space Exploration

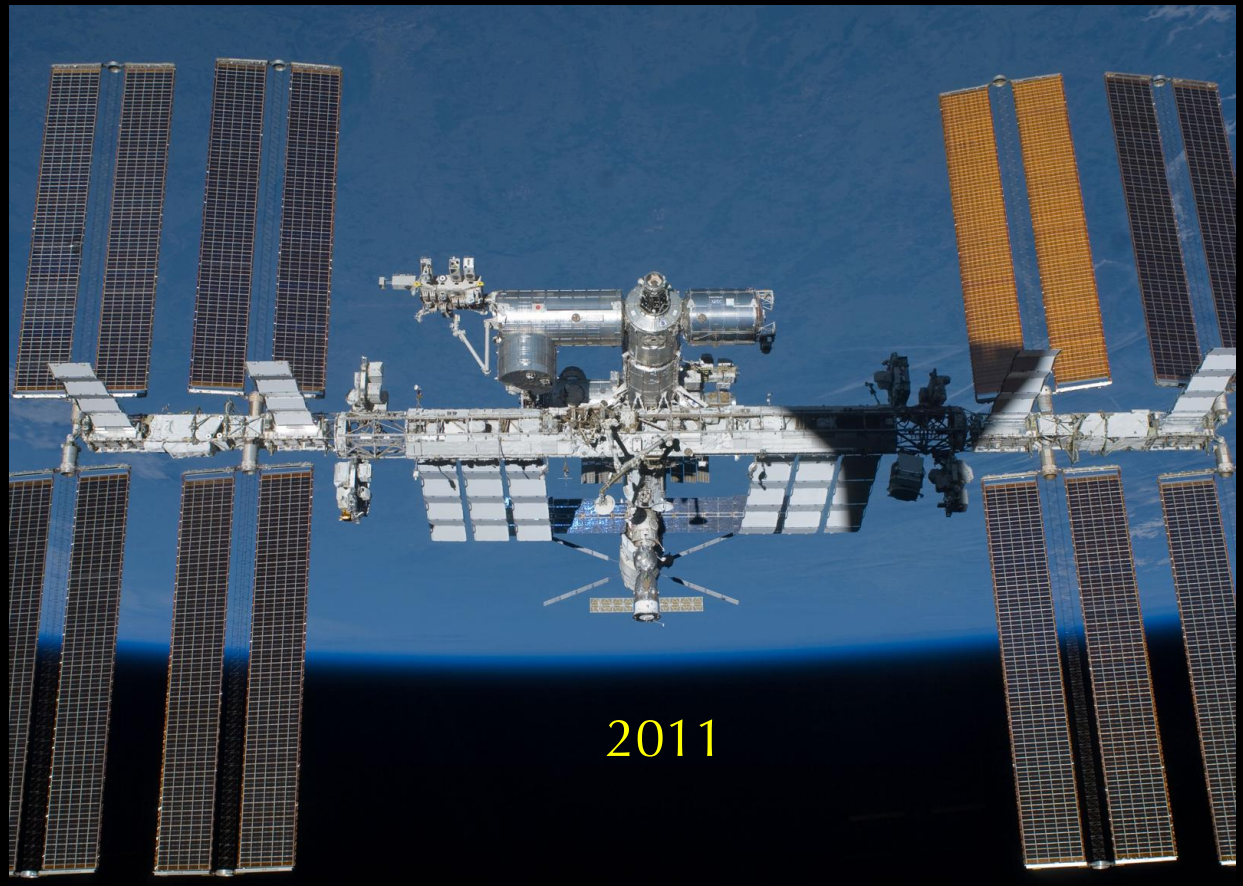


Strategy:

- ✧ Use the International Space Station as a research lab and test bed for new technologies
- ✧ Foster a commercial industry to take us to and from low Earth orbit
- ✧ Develop technologies to take humans to an asteroid and eventually to Mars

International Space Station

1998



2011

An incredible orbiting research lab

1.5 billion statute miles +

16 nations 202 astronauts

74 Russian vehicles, 37 space shuttles, two European and two Japanese vehicles

Foster U.S. Industry to Carry People and Cargo to/from Low Earth Orbit

Sierra Nevada
Dream Chaser

Space-X
Falcon 9 and Dragon

Boeing
CST-100

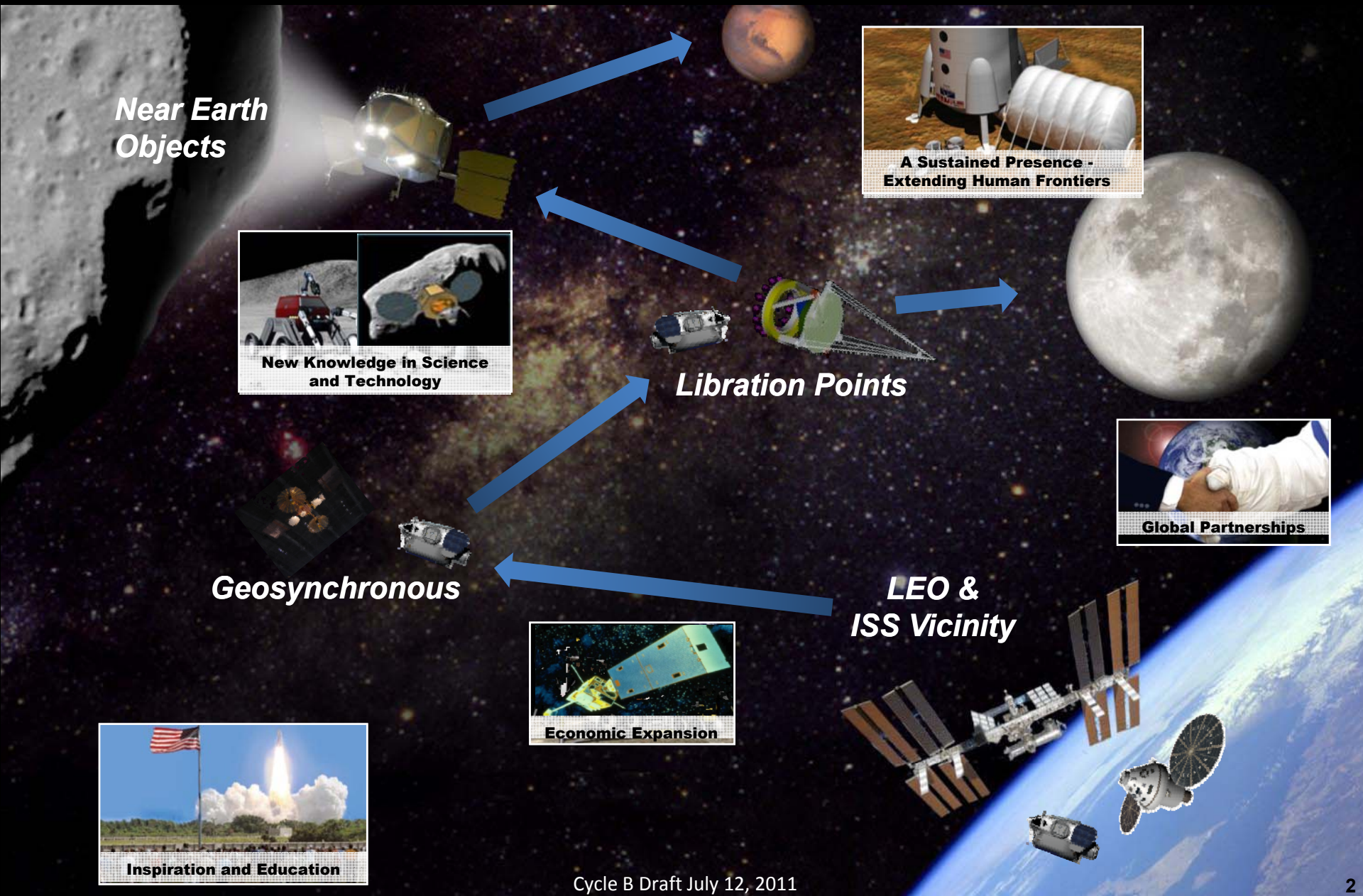
Blue Origin

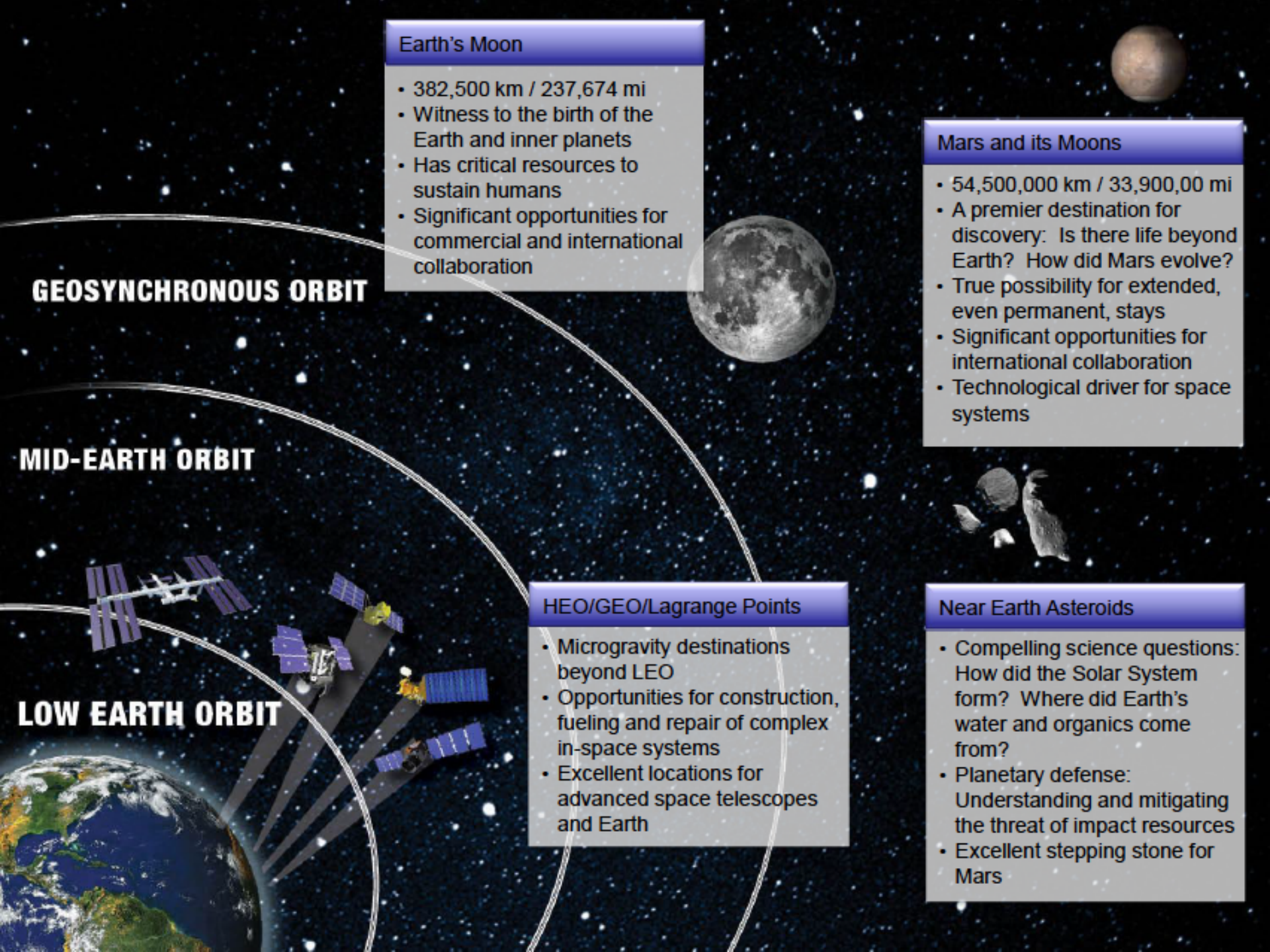
Space Tourism: non-NASA Ventures

Virgin Galactic

XCOR Aerospace

NASA is Building the Capability to Go Further





Earth's Moon

- 382,500 km / 237,674 mi
- Witness to the birth of the Earth and inner planets
- Has critical resources to sustain humans
- Significant opportunities for commercial and international collaboration

Mars and its Moons

- 54,500,000 km / 33,900,00 mi
- A premier destination for discovery: Is there life beyond Earth? How did Mars evolve?
- True possibility for extended, even permanent, stays
- Significant opportunities for international collaboration
- Technological driver for space systems

HEO/GEO/Lagrange Points

- Microgravity destinations beyond LEO
- Opportunities for construction, fueling and repair of complex in-space systems
- Excellent locations for advanced space telescopes and Earth

Near Earth Asteroids

- Compelling science questions: How did the Solar System form? Where did Earth's water and organics come from?
- Planetary defense: Understanding and mitigating the threat of impact resources
- Excellent stepping stone for Mars

Tomorrow's missions are demanding more …

More places

More data processing

More autonomy

WHAT TECHNOLOGIES ARE NEEDED?

14 Technology Areas

TA01  • Launch Propulsion Systems

TA02  • In-Space Propulsion Technologies

TA03  • Space Power & Energy Storage

TA04  • Robotics, Tele-robotics & Autonomous Systems

TA05  • Communication & Navigation

TA06  • Human Health, Life Support & Habitation Systems

TA07  • Human Exploration Destination Systems

TA08  • Science Instruments, Observatories & Sensor Systems

TA09  • Entry, Descent & Landing Systems

TA10  • Nanotechnology

TA11  • Modeling, Simulation, Information Technology & Processing

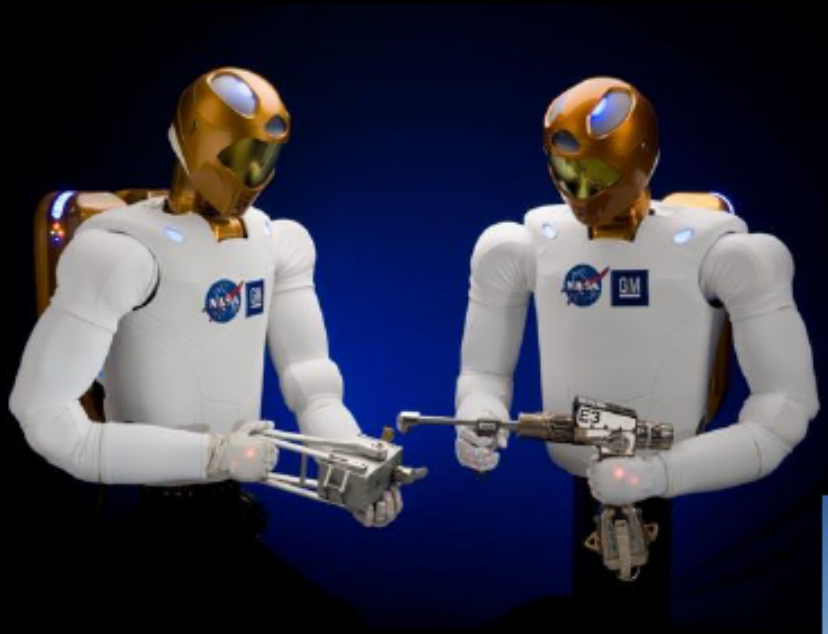
TA12  • Materials, Structures, Mechanical Systems & Manufacturing

TA13  • Ground & Launch Systems Processing

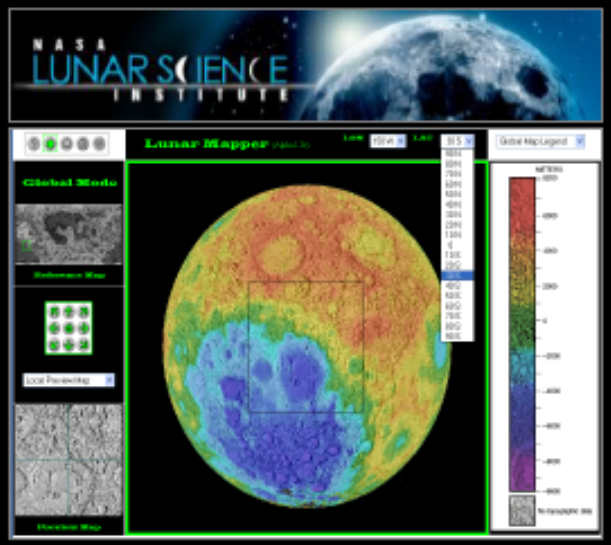
TA14  • Thermal Management Systems

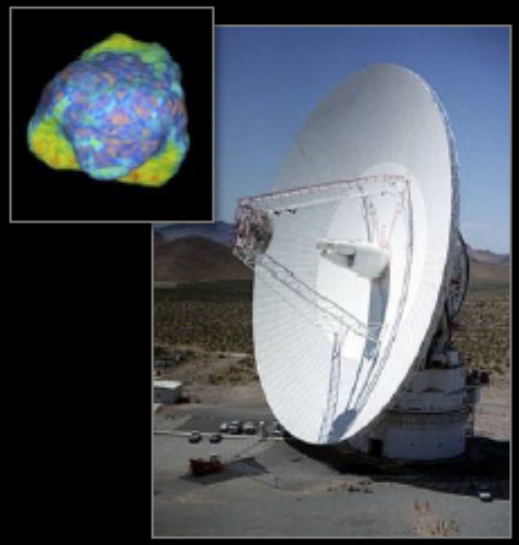
What new capabilities can be created?

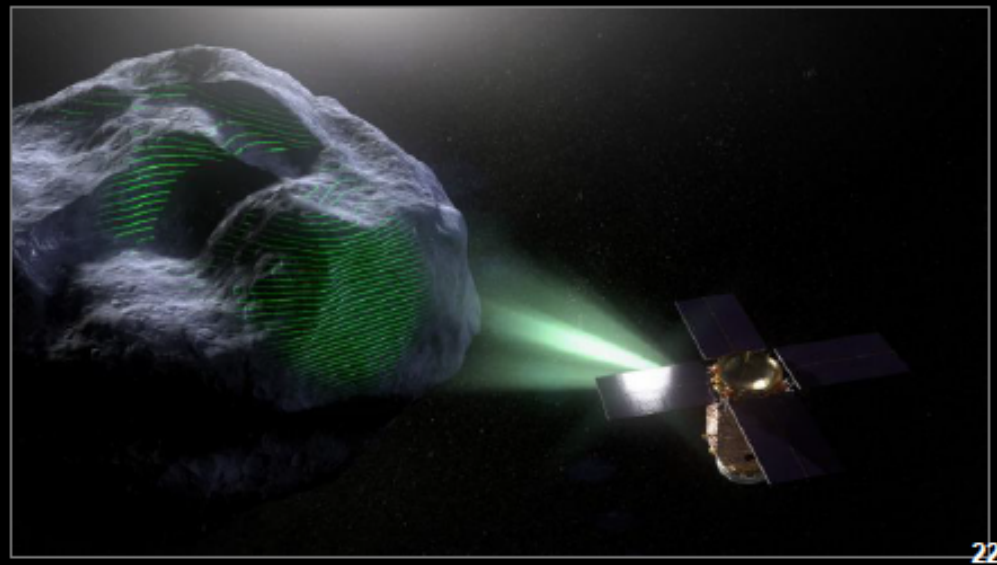
Technology Developments



Robotic Precursor Missions Pave the Way for Future Human Exploration Missions

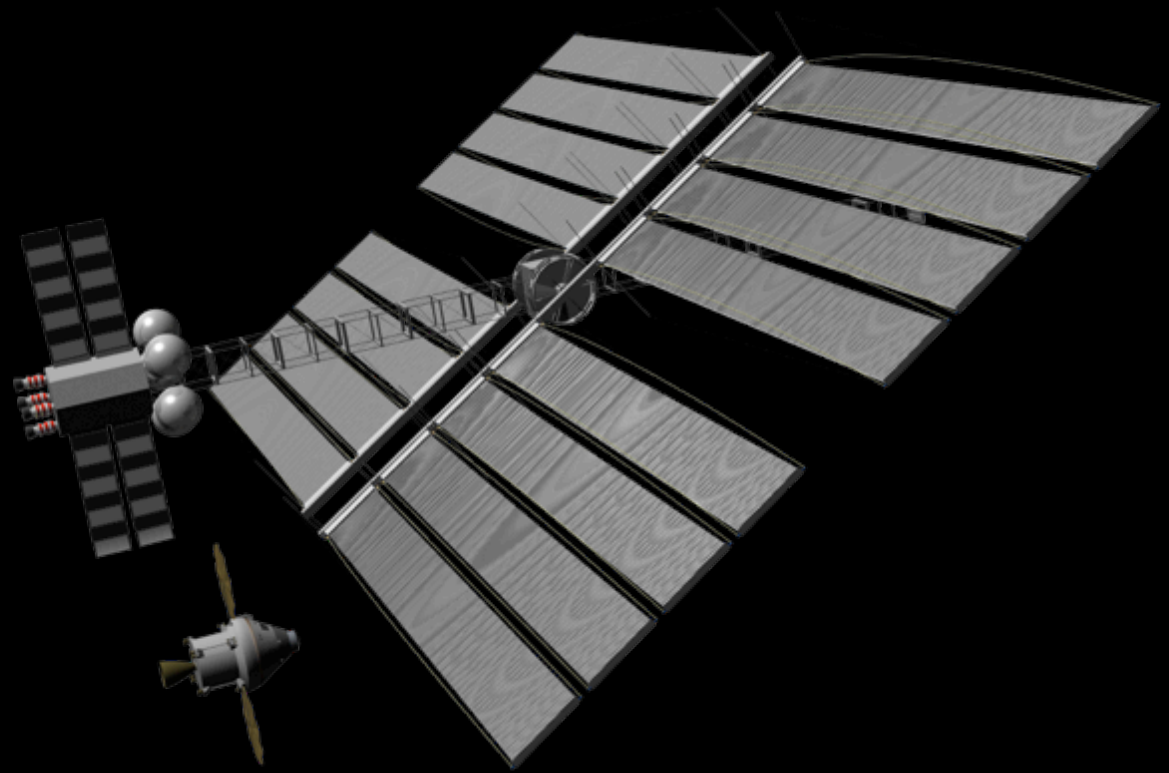




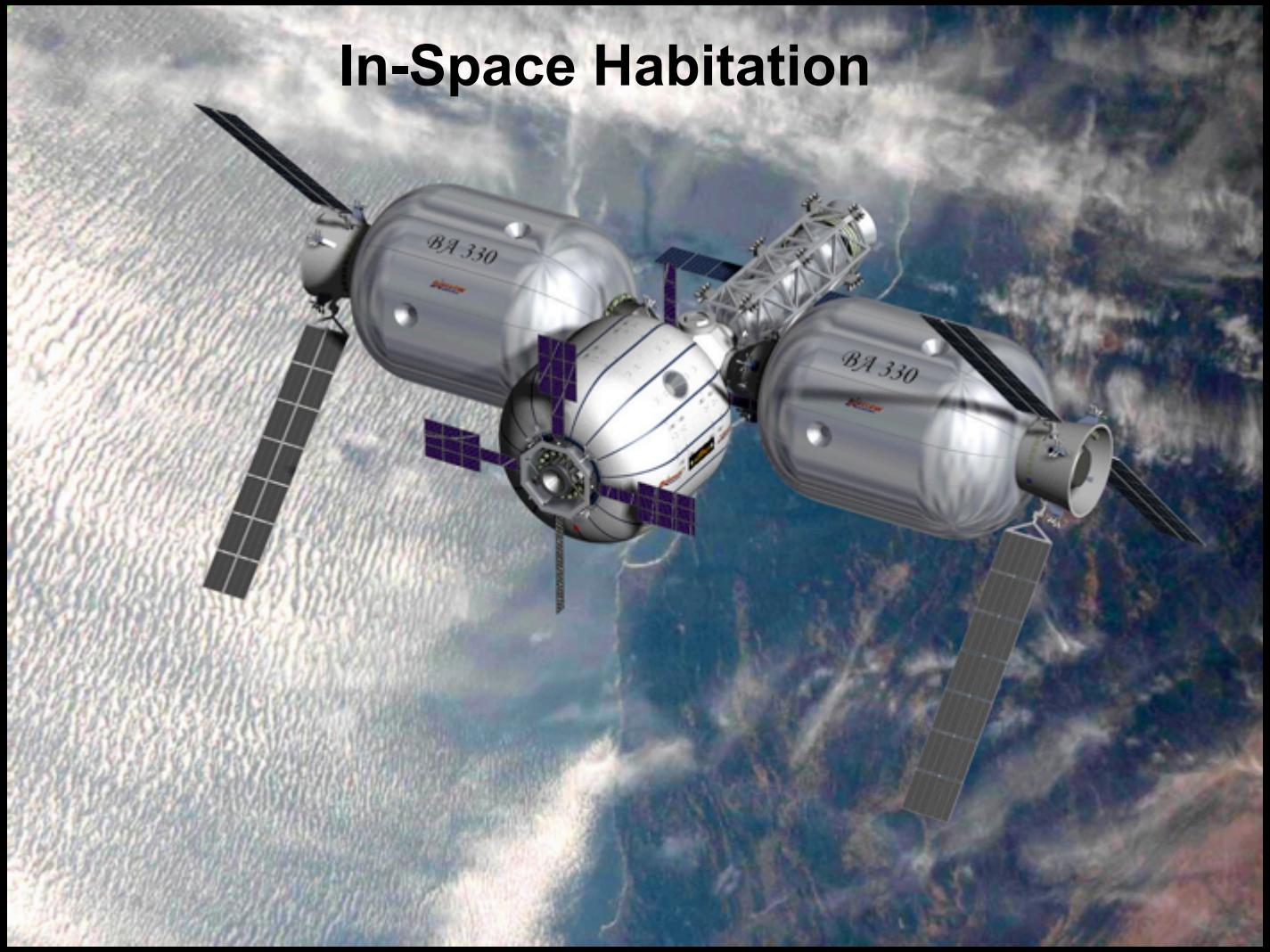


Orion Multi-Purpose Crew Vehicle and Space Launch System

Solar Electric Propulsion

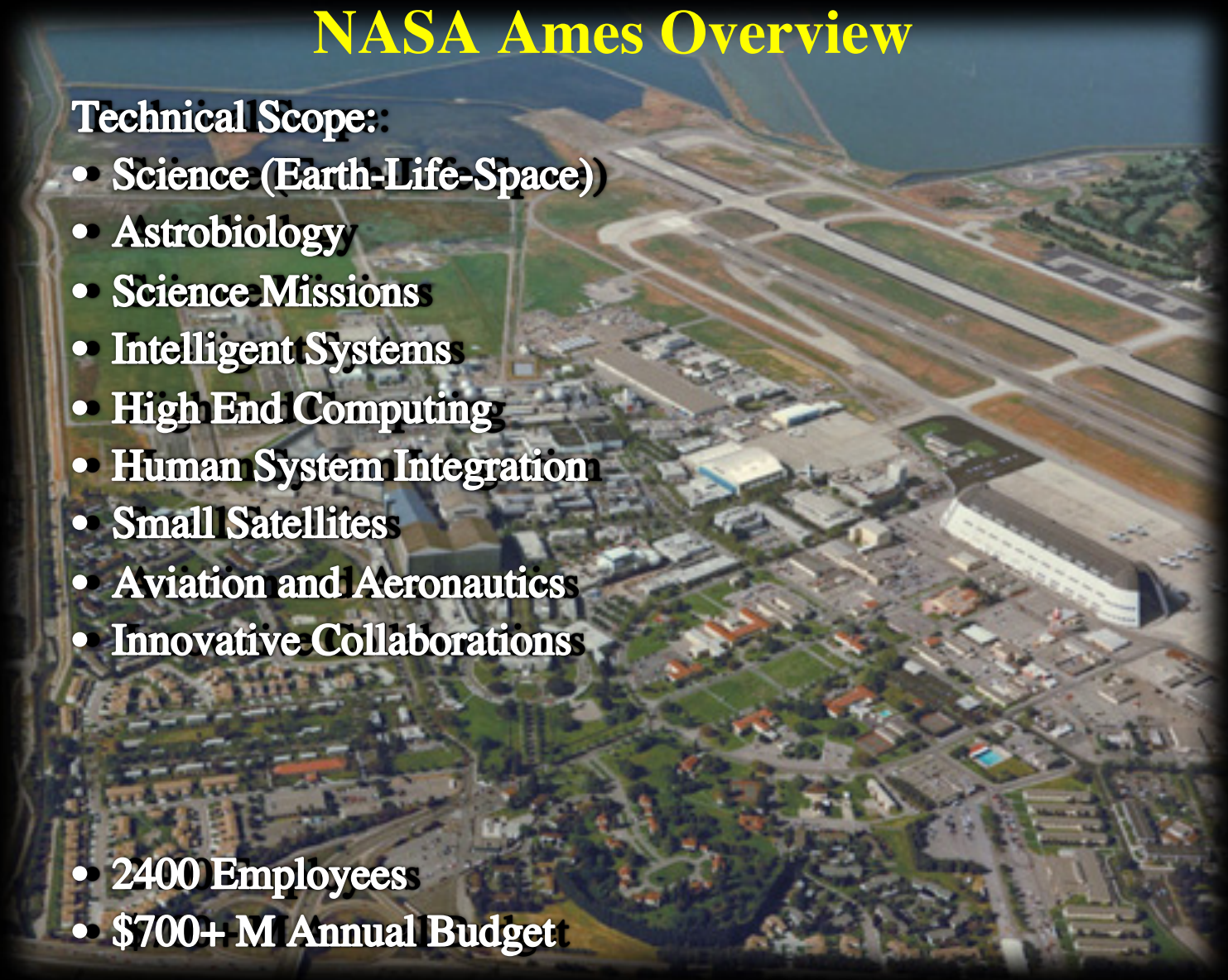


In-Space Habitation



Planetary Transportation System

NASA Ames Overview



Technical Scope:

- Science (Earth-Life-Space)
- Astrobiology
- Science Missions
- Intelligent Systems
- High End Computing
- Human System Integration
- Small Satellites
- Aviation and Aeronautics
- Innovative Collaborations

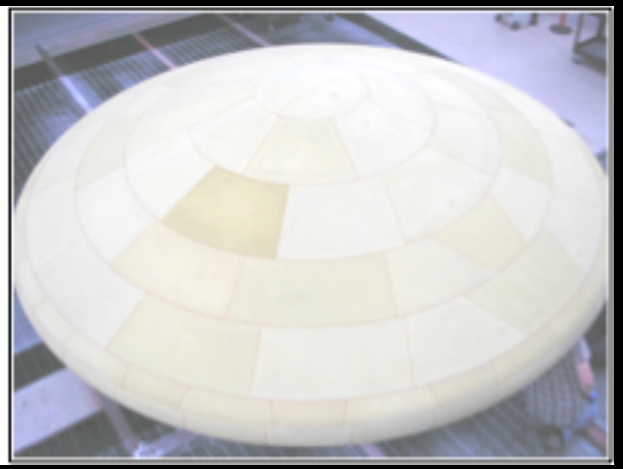
- 2400 Employees
- $700+ M Annual Budget

Questions?

Thermal Protection Systems Research

- **State of the art low density carbon ablators are used for current mission but have challenges**
  - Low strain to failure
  - Brittle char
  - Needs strain isolation pads and gap fillers in tiled configurations

Orion Heat Shield
(5 m diameter)

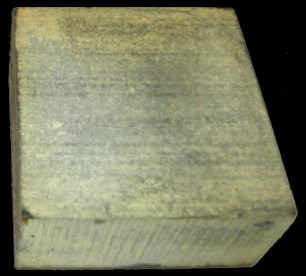


MSL Heat Shield
(4.5 m diameter)

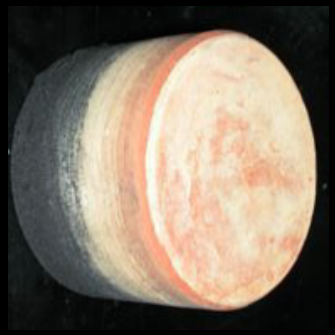
1

Thermal Protection Materials Research at Ames

Rigid Ablators

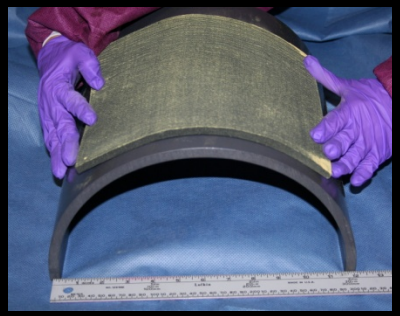


Advanced PICA -like ablators



Graded Ablators

Conformable Ablators



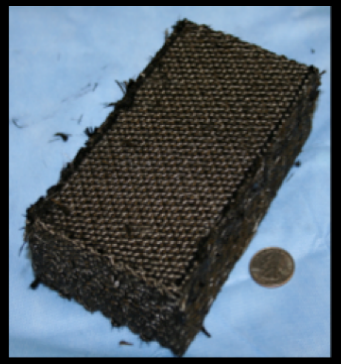
Conformable PICA

Flexible Ablators

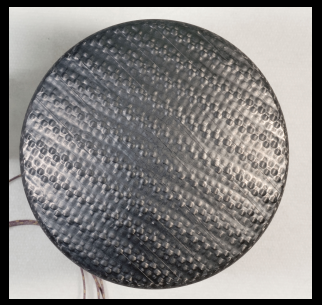
Flexible PICA

Flexible SIRCA

Woven TPS



Mid density TPS

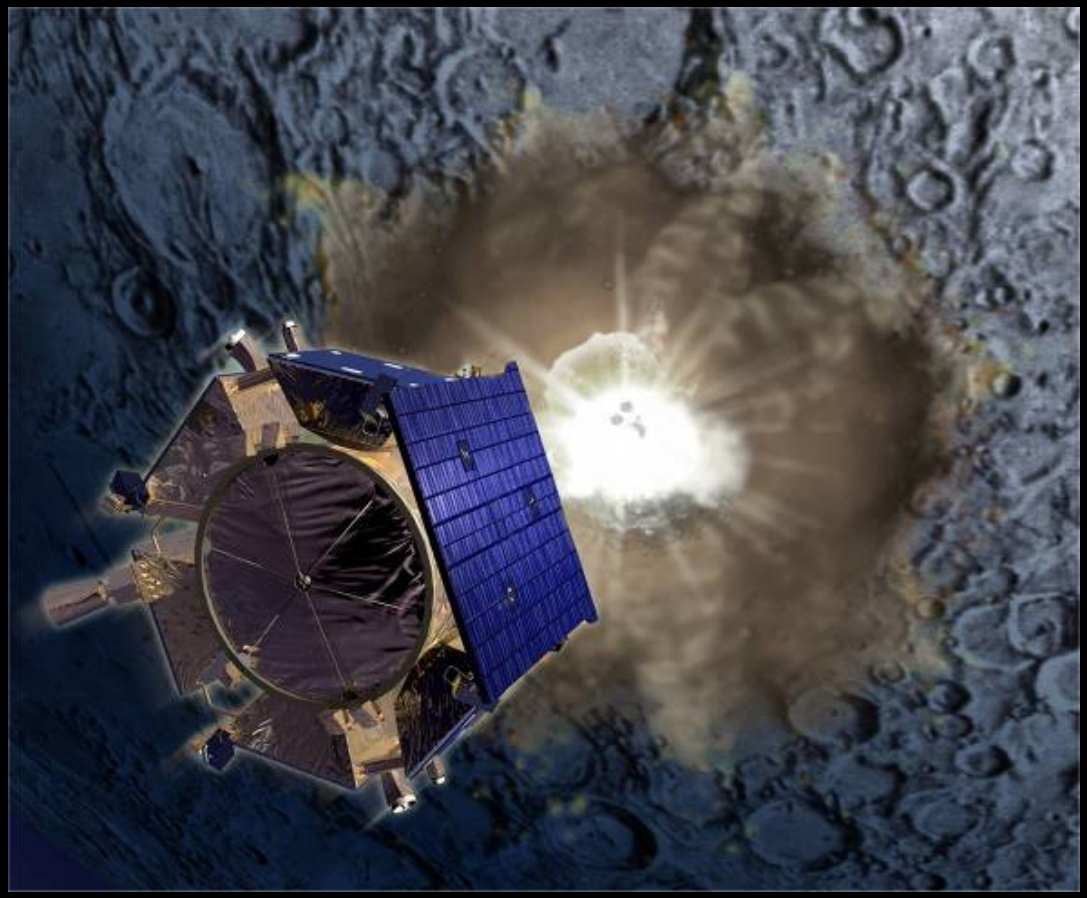


Carbon phenolic replacement

2

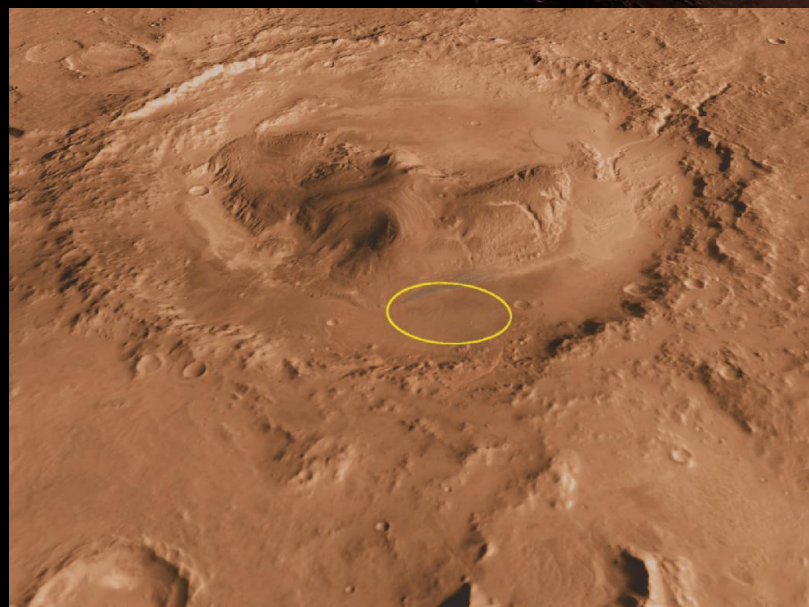
SCIENCE HIGHLIGHTS

Water on the Moon - LCROSS

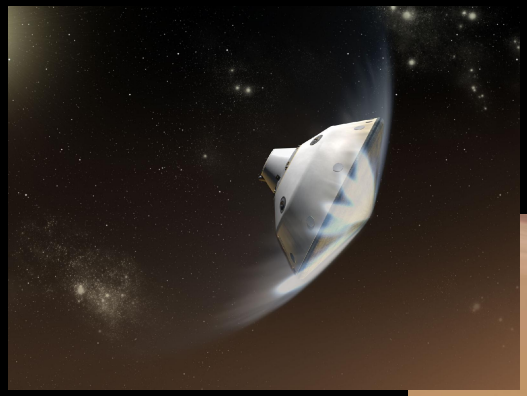


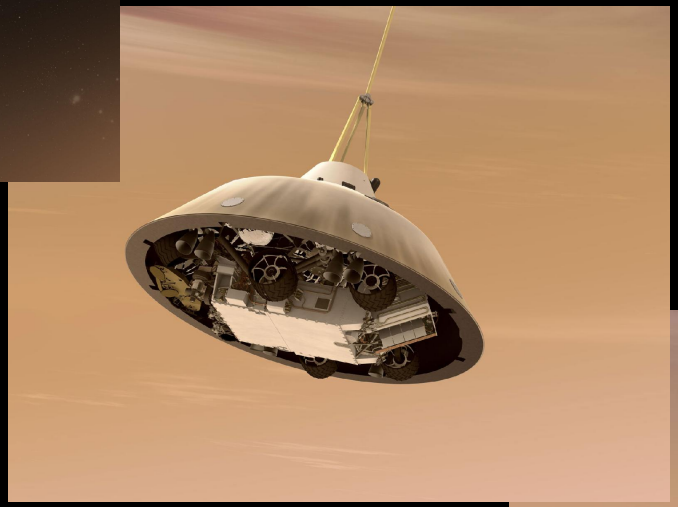
Changed our understanding of the moon

Destination Mars: Gale Crater



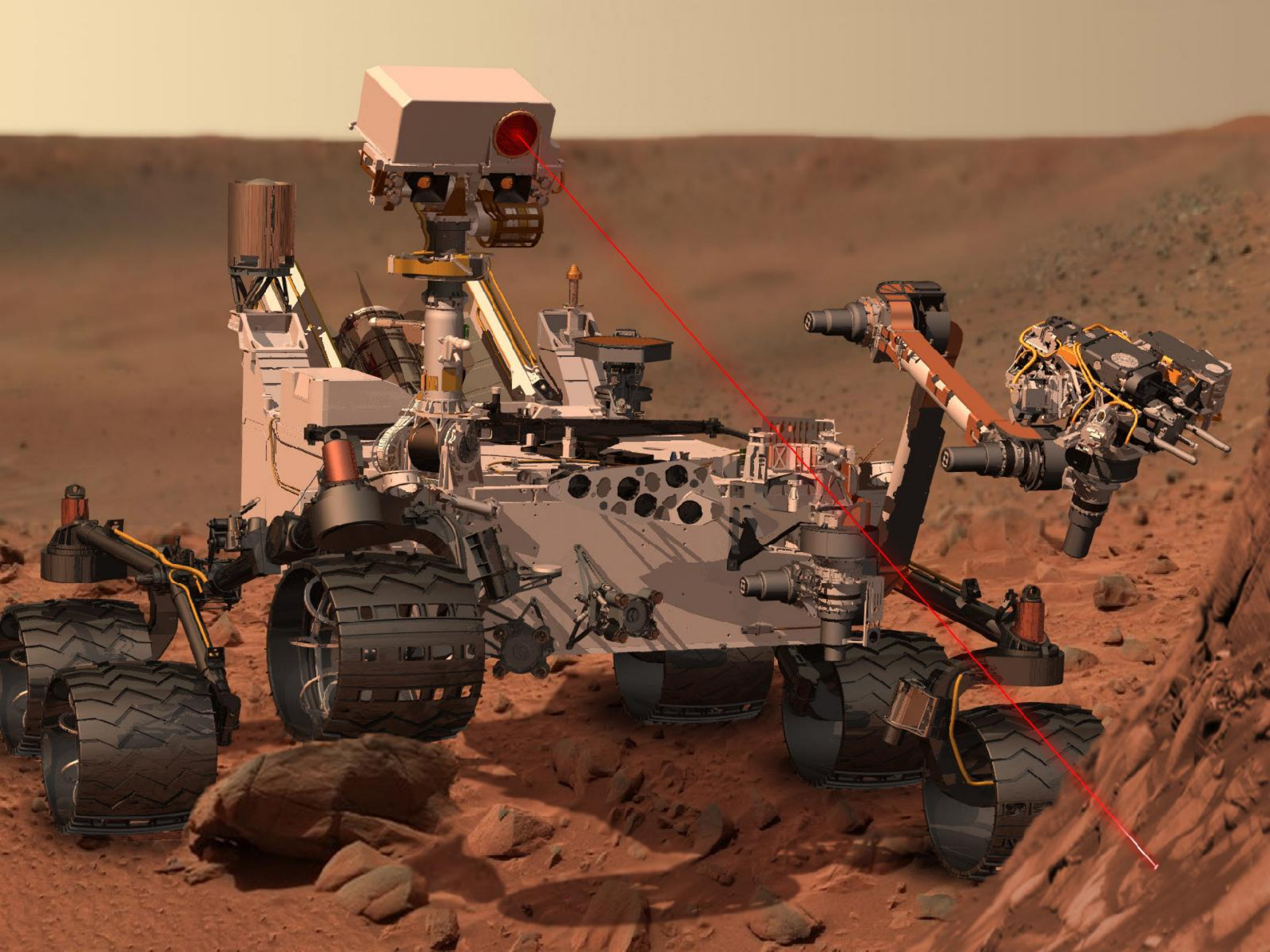
New Landing System: Mars Sky Crane





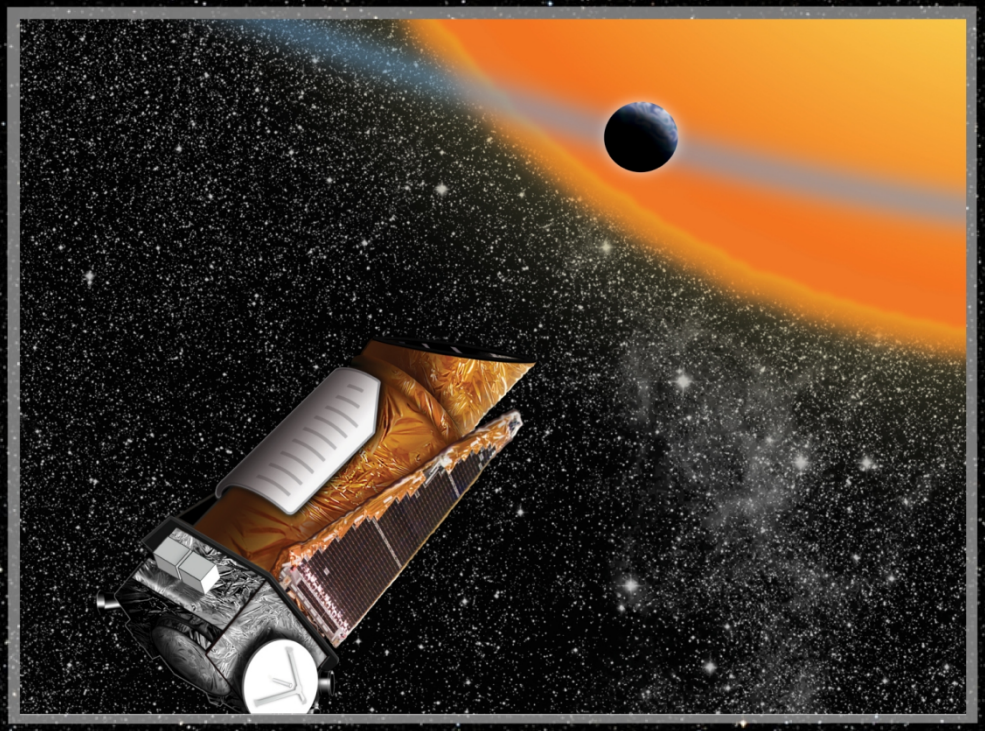
Curiosity – The Next Mars Rover

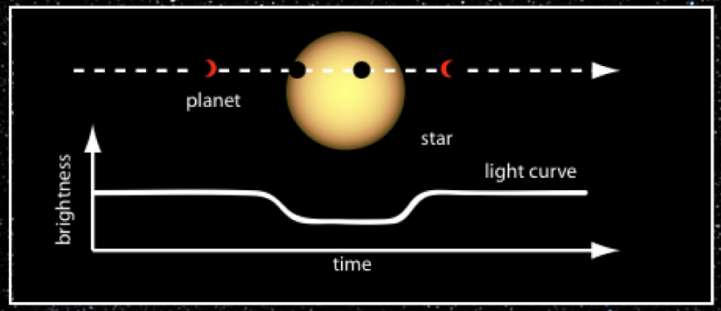
http://www.nasa.gov/mission_pages/msl

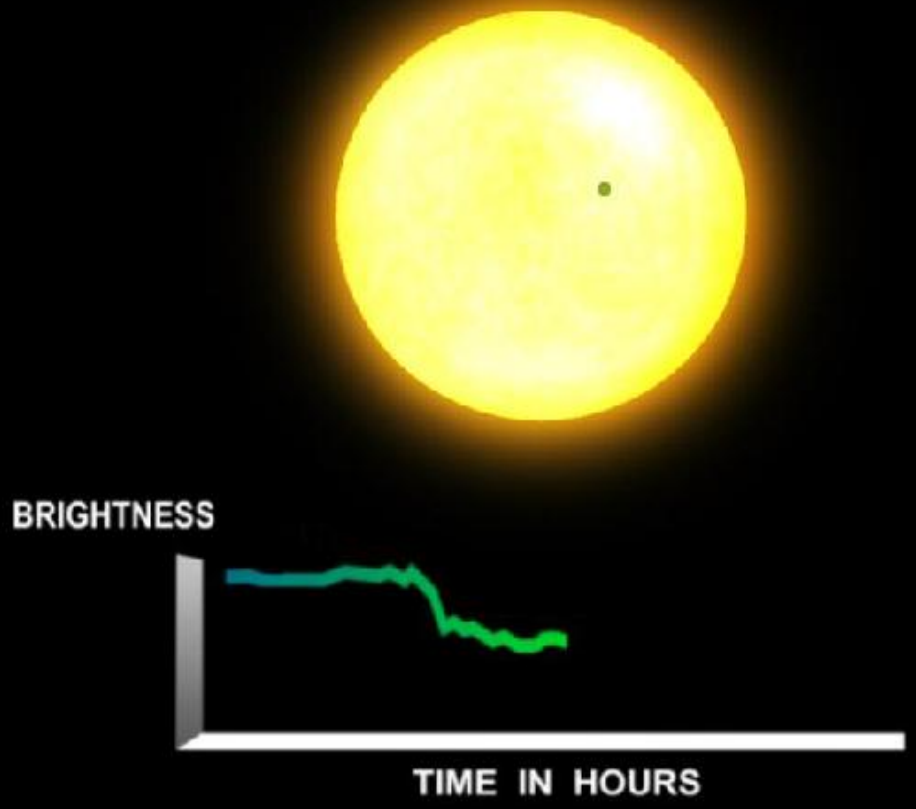


Kepler Mission

The determination of the frequency of Earth-size & larger planets in and near the habitable zone of solar-like stars



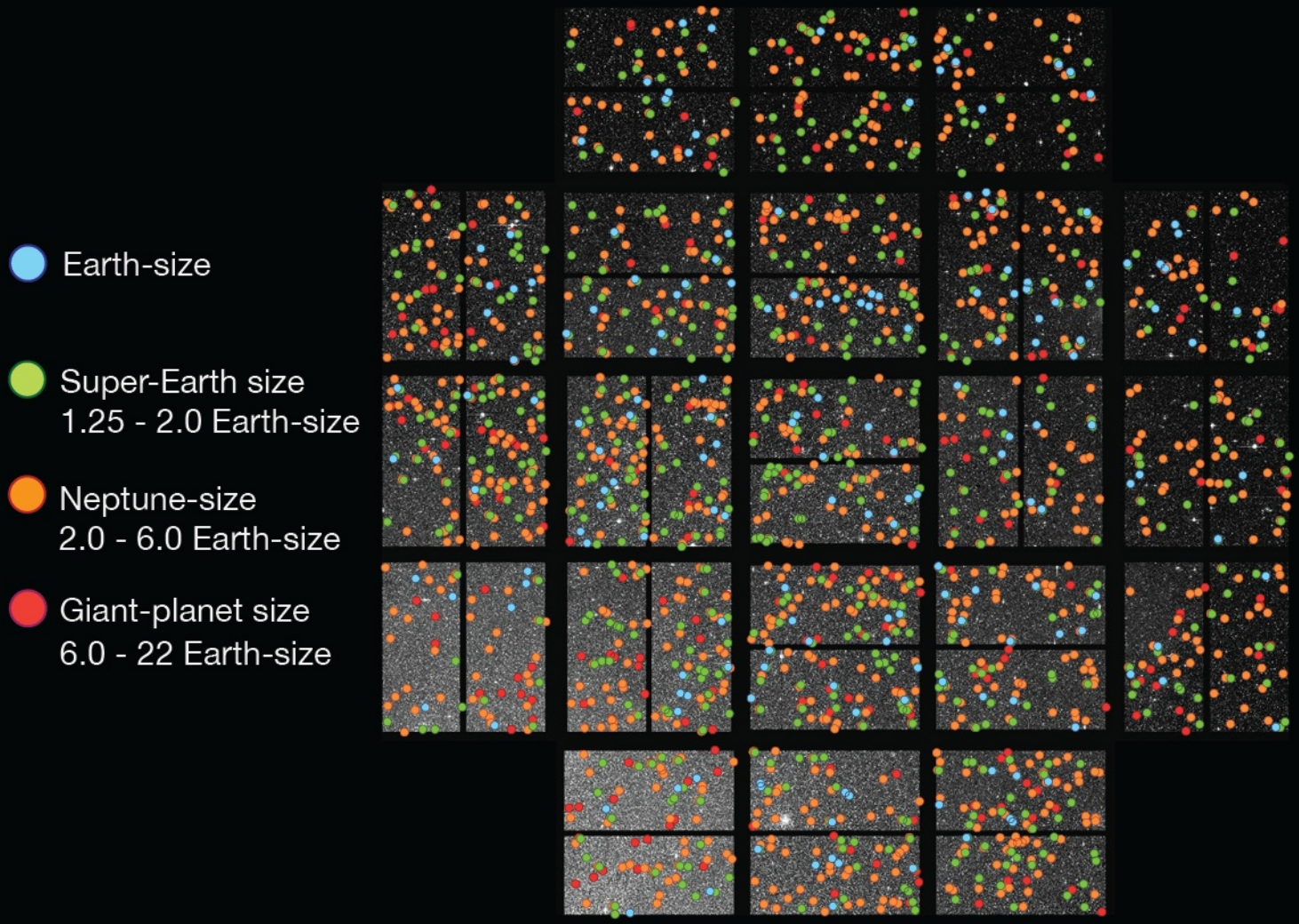


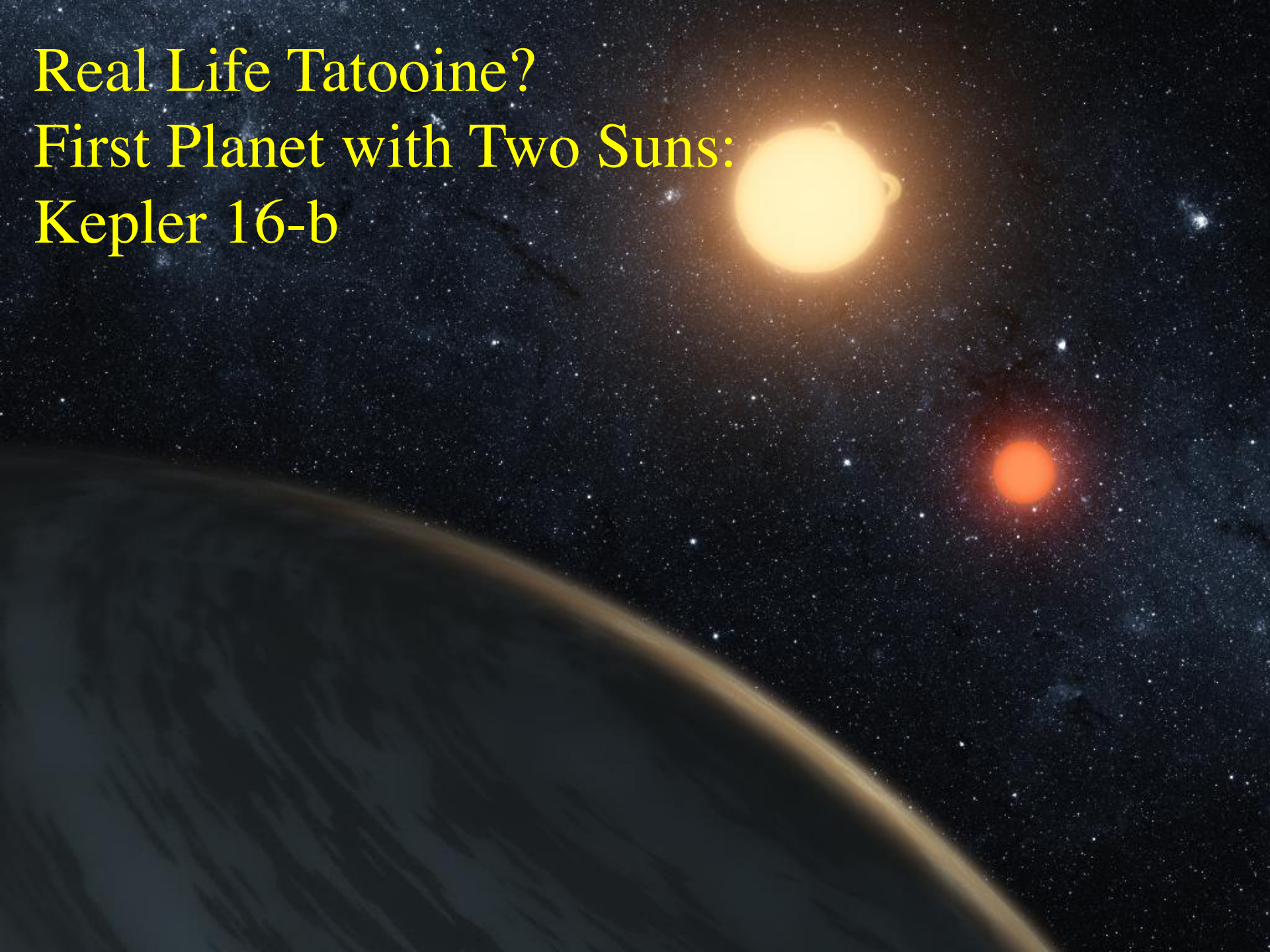


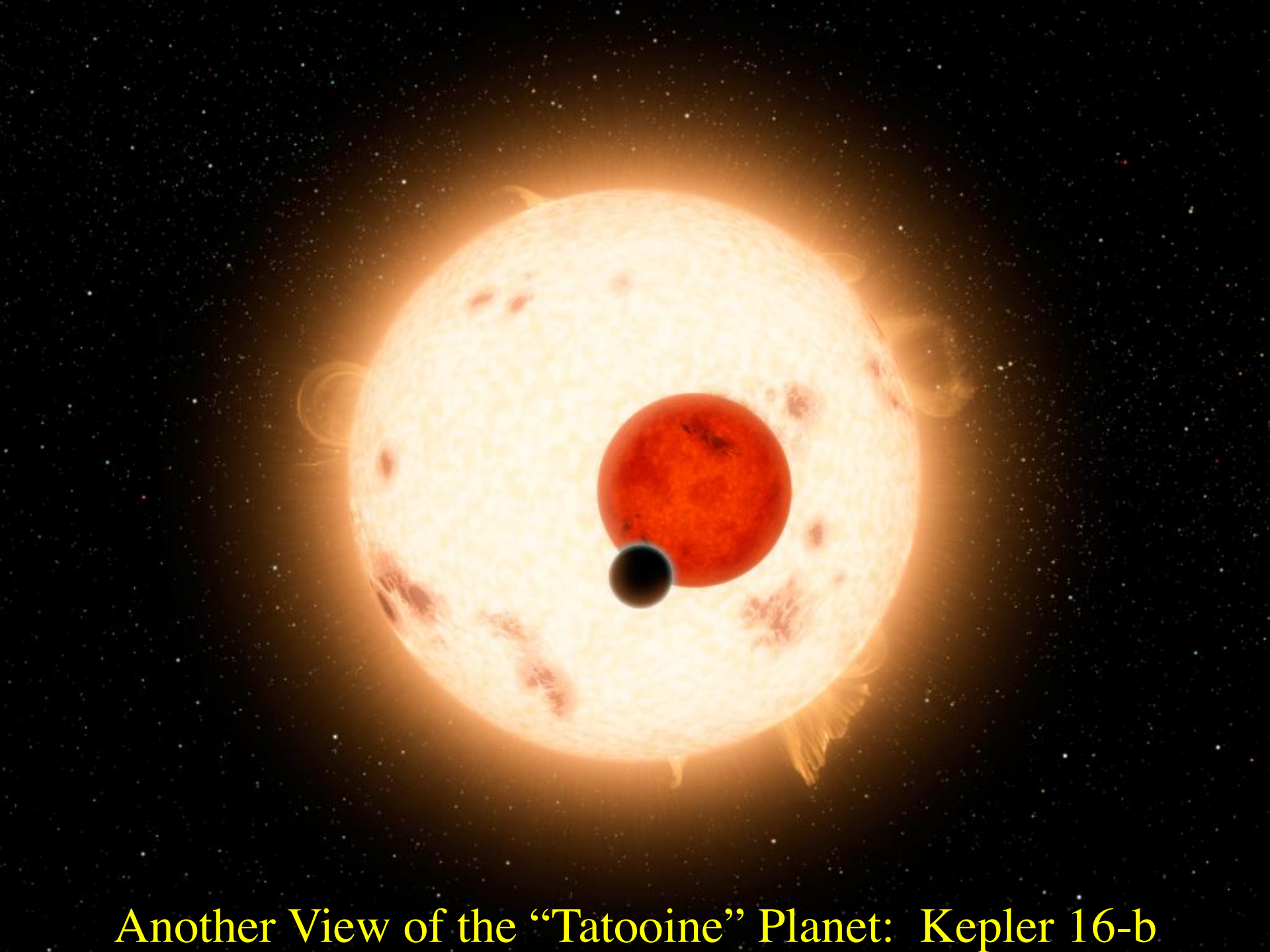
Kepler uses light curves to detect new planets

Locations of Kepler Planet Candidates

As of December 5, 2011

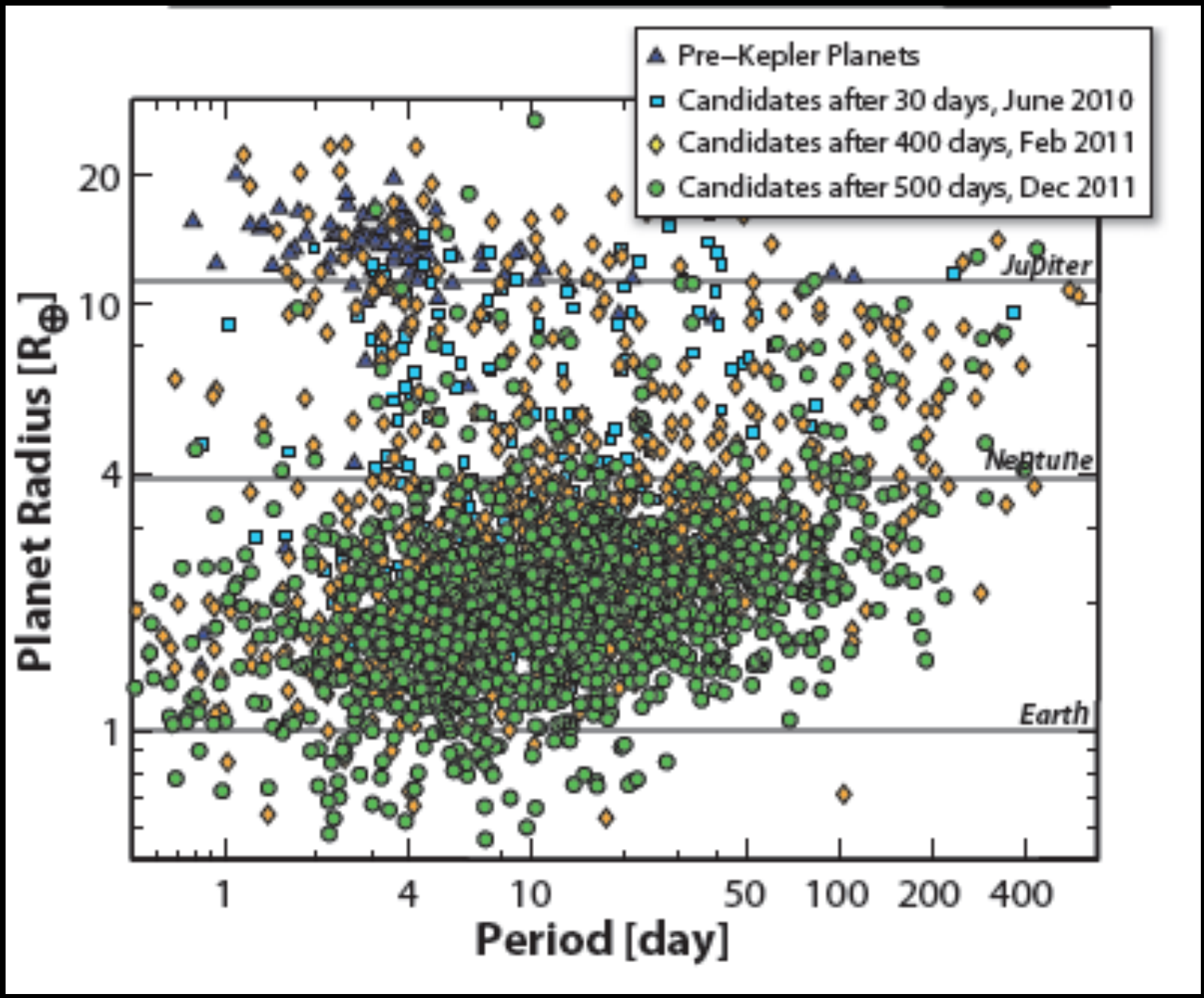



Real Life Tatooine?
First Planet with Two Suns:
Kepler 16-b



Another View of the “Tatooine” Planet: Kepler 16-b

Out of this world Solar System orbiting Kepler 11


Pre–Kepler Planets
Candidates after 30 days, June 2010
Candidates after 400 days, Feb 2011
Candidates after 500 days, Dec 2011
Jupiter
Neptune
Earth
Planet Radius [R⊕]
20
10
4
1
1
4
10
50
100
200
400
Period [day]

Looking Towards the Future

- ISS will be the centerpiece of human spaceflight activities until at least 2020
- Research and technology breakthroughs aboard ISS will facilitate travel to destinations beyond low Earth orbit
- Destinations for human exploration remain ambitious: the Moon, asteroids and Mars
- Continue to undertake world-class science missions to observe our planet, reach destinations throughout the solar system and peer even deeper into the universe
- Advance aeronautics research to create a safer, more environmentally friendly and efficient air travel network for the Next Generation Air Transportation System
- Continue to inspire the next generation of scientists, engineers and astronauts by focusing on STEM education initiatives

Student Opportunities: Many student internship, fellowship, and post-doc opportunities across NASA

http://intern.nasa.gov
http://eap.usra.edu
http://nasa.orau.org/postdoc

Questions?